Fig.1

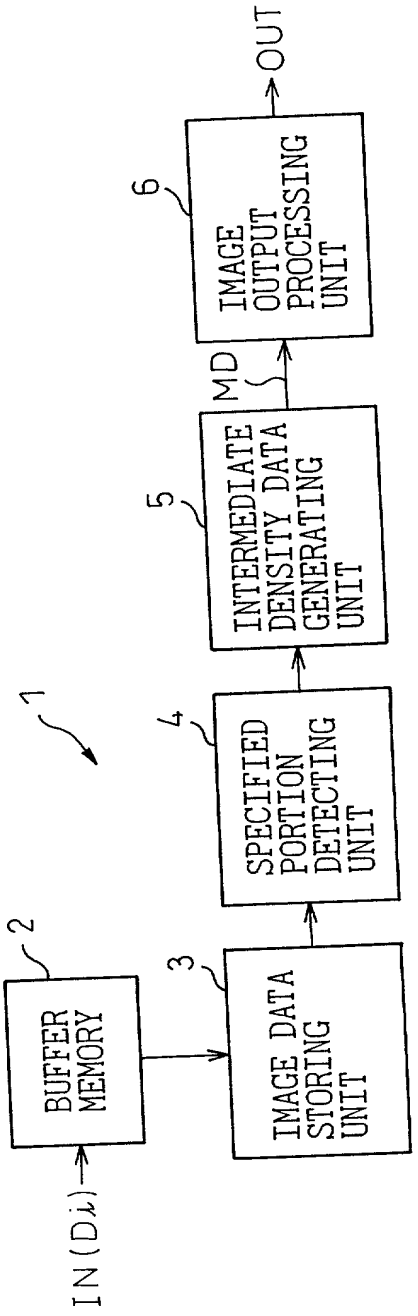

IN (Di)
BUFFER MEMORY
2
IMAGE DATA STORING UNIT
3
SPECIFIED PORTION DETECTING UNIT
4
INTERMEDIATE DENSITY DATA GENERATING UNIT
5
MD
IMAGE OUTPUT PROCESSING UNIT
6
OUT
1

Fig.2

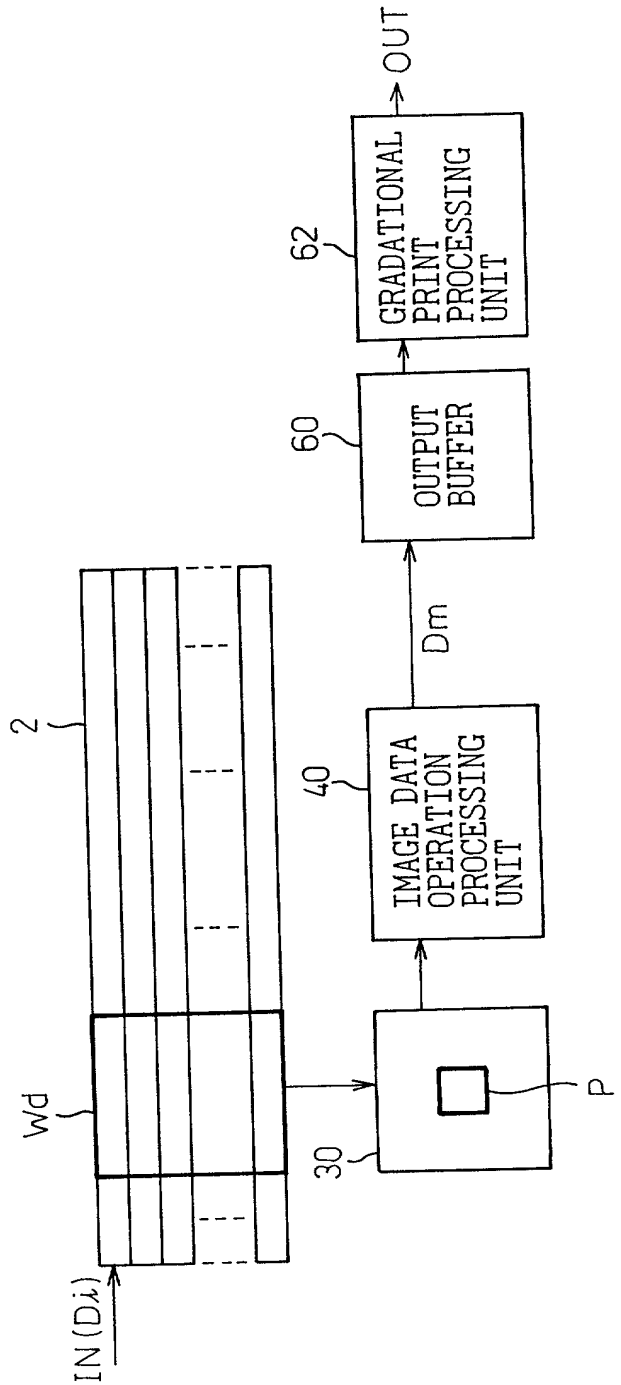

IN (Di)
2
Wd
30
P
40
IMAGE DATA OPERATION PROCESSING UNIT
Dm
60
OUTPUT BUFFER
62
GRADATIONAL PRINT PROCESSING UNIT
OUT

Fig.3

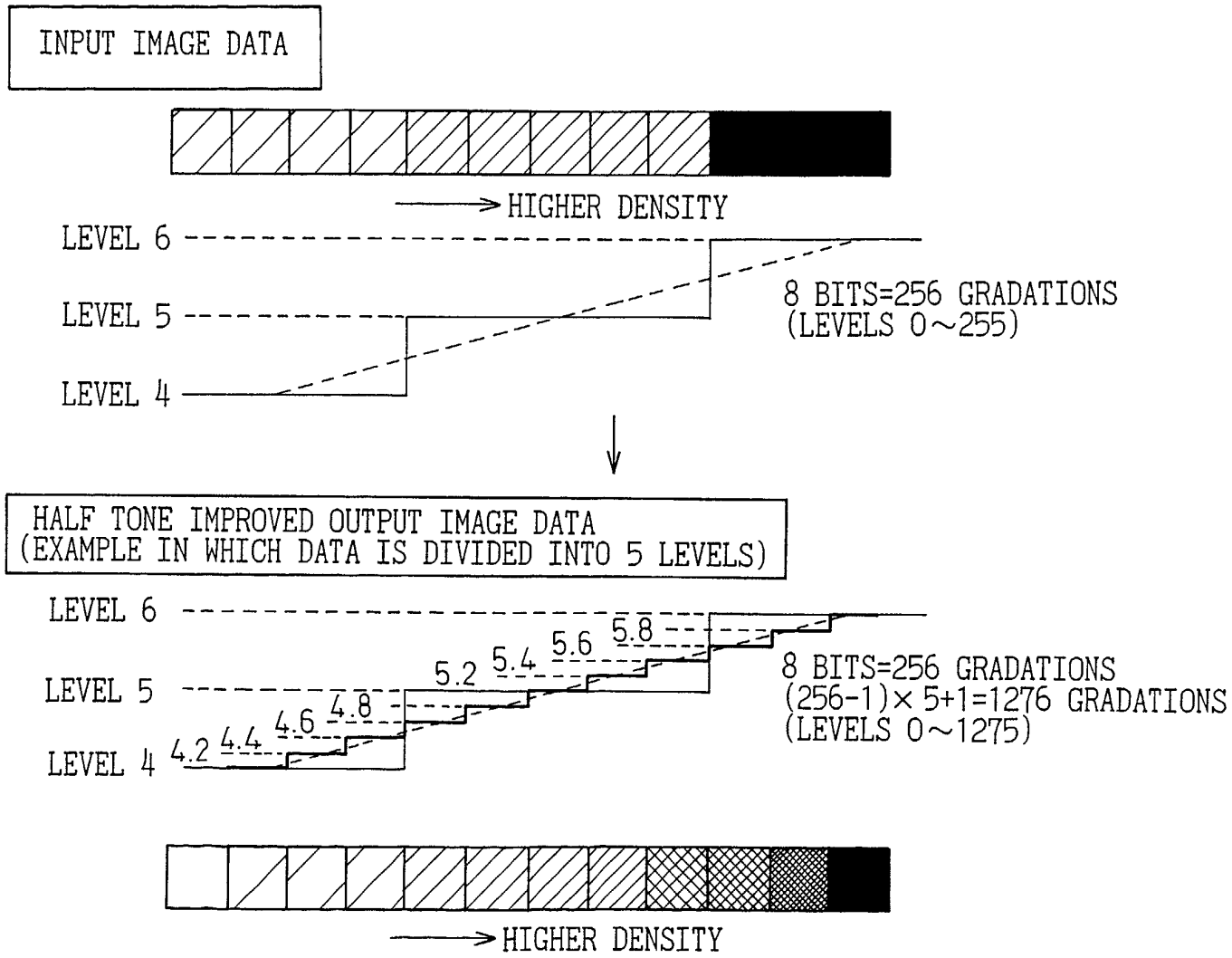

INPUT IMAGE DATA
HIGHER DENSITY
LEVEL 6
LEVEL 5
LEVEL 4
8 BITS=256 GRADATIONS
(LEVELS 0~255)
HALF TONE IMPROVED OUTPUT IMAGE DATA
(EXAMPLE IN WHICH DATA IS DIVIDED INTO 5 LEVELS)
LEVEL 6
LEVEL 5
LEVEL 4
4.2
4.4
4.6
4.8
5.2
5.4
5.6
5.8
8 BITS=256 GRADATIONS
(256-1)×5+1=1276 GRADATIONS
(LEVELS 0~1275)
HIGHER DENSITY

Fig. 4

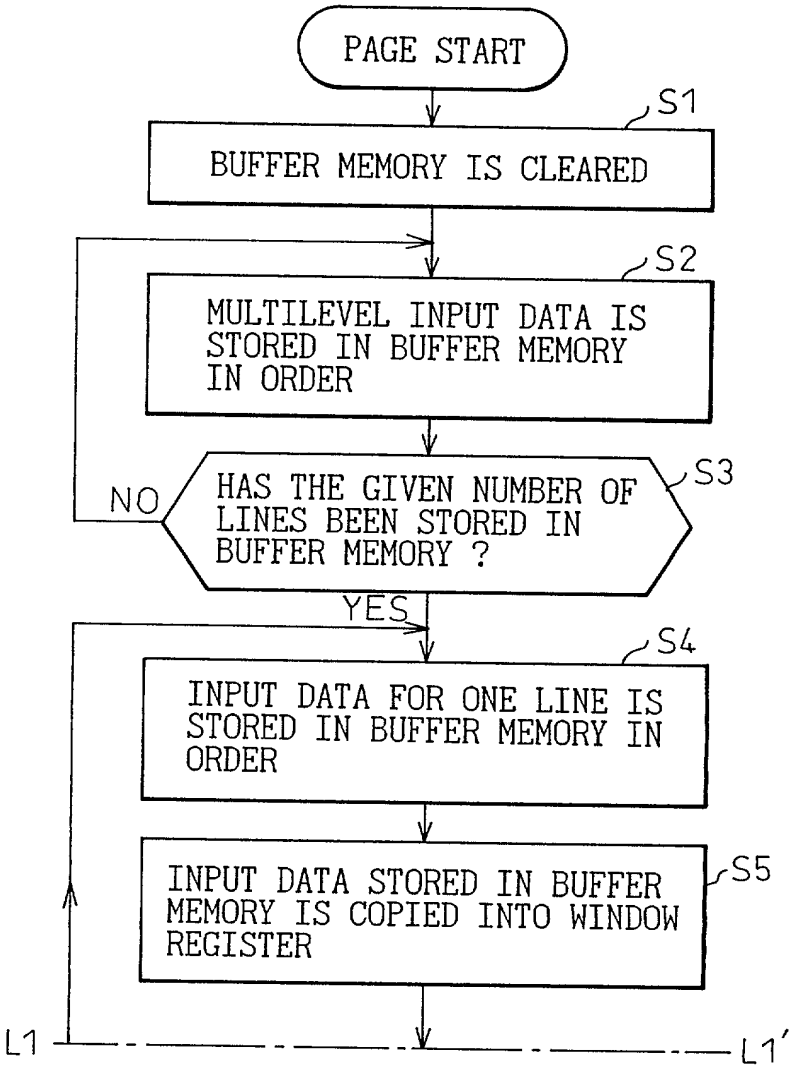

PAGE START
S1
BUFFER MEMORY IS CLEARED
S2
MULTILEVEL INPUT DATA IS STORED IN BUFFER MEMORY IN ORDER
S3
NO
HAS THE GIVEN NUMBER OF LINES BEEN STORED IN BUFFER MEMORY ?
YES
S4
INPUT DATA FOR ONE LINE IS STORED IN BUFFER MEMORY IN ORDER
S5
INPUT DATA STORED IN BUFFER MEMORY IS COPIED INTO WINDOW REGISTER
L1
L1'

Fig.5

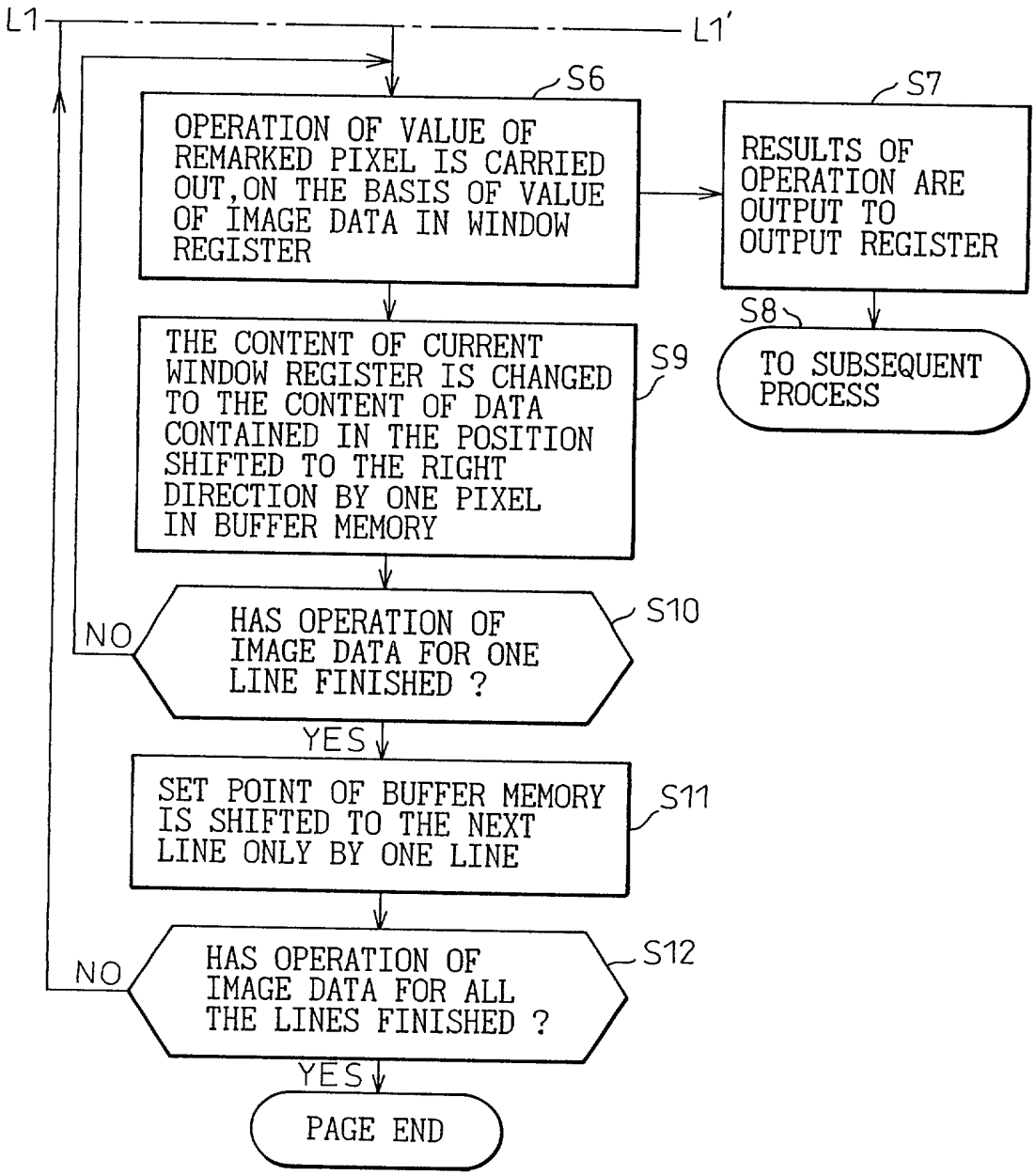
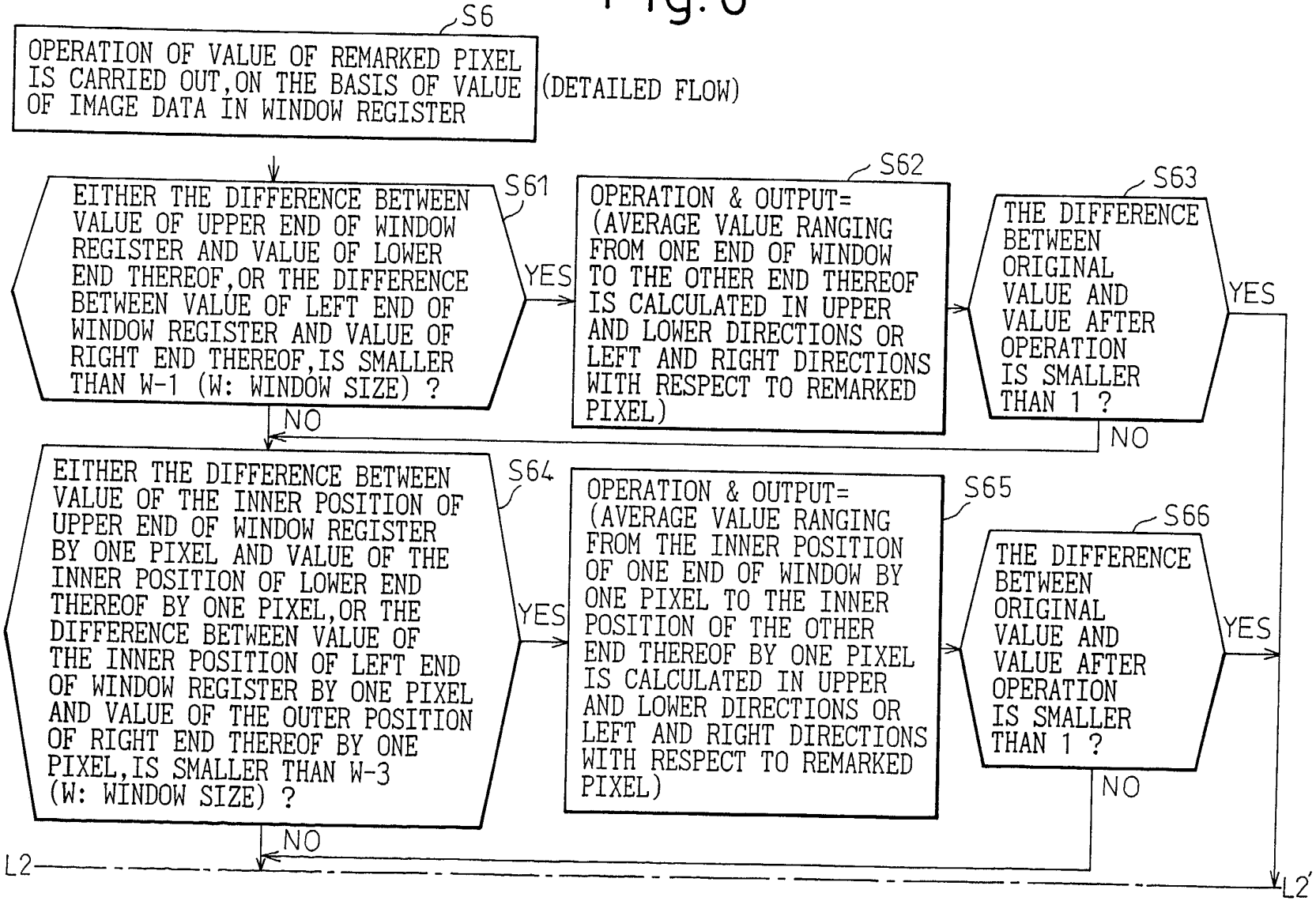

L1
L1'
S6
OPERATION OF VALUE OF REMARKED PIXEL IS CARRIED OUT, ON THE BASIS OF VALUE OF IMAGE DATA IN WINDOW REGISTER
S7
RESULTS OF OPERATION ARE OUTPUT TO OUTPUT REGISTER
S8
TO SUBSEQUENT PROCESS
S9
THE CONTENT OF CURRENT WINDOW REGISTER IS CHANGED TO THE CONTENT OF DATA CONTAINED IN THE POSITION SHIFTED TO THE RIGHT DIRECTION BY ONE PIXEL IN BUFFER MEMORY
S10
NO
HAS OPERATION OF IMAGE DATA FOR ONE LINE FINISHED ?
YES
S11
SET POINT OF BUFFER MEMORY IS SHIFTED TO THE NEXT LINE ONLY BY ONE LINE
S12
NO
HAS OPERATION OF IMAGE DATA FOR ALL THE LINES FINISHED ?
YES
PAGE END

Fig.6


S6
OPERATION OF VALUE OF REMARKED PIXEL IS CARRIED OUT, ON THE BASIS OF VALUE OF IMAGE DATA IN WINDOW REGISTER
(DETAILED FLOW)
S61
EITHER THE DIFFERENCE BETWEEN VALUE OF UPPER END OF WINDOW REGISTER AND VALUE OF LOWER END THEREOF, OR THE DIFFERENCE BETWEEN VALUE OF LEFT END OF WINDOW REGISTER AND VALUE OF RIGHT END THEREOF, IS SMALLER THAN W-1 (W: WINDOW SIZE) ?
YES
NO
S62
OPERATION & OUTPUT= (AVERAGE VALUE RANGING FROM ONE END OF WINDOW TO THE OTHER END THEREOF IS CALCULATED IN UPPER AND LOWER DIRECTIONS OR LEFT AND RIGHT DIRECTIONS WITH RESPECT TO REMARKED PIXEL)
S63
THE DIFFERENCE BETWEEN ORIGINAL VALUE AND VALUE AFTER OPERATION IS SMALLER THAN 1 ?
YES
NO
S64
EITHER THE DIFFERENCE BETWEEN VALUE OF THE INNER POSITION OF UPPER END OF WINDOW REGISTER BY ONE PIXEL AND VALUE OF THE INNER POSITION OF LOWER END THEREOF BY ONE PIXEL, OR THE DIFFERENCE BETWEEN VALUE OF THE INNER POSITION OF LEFT END OF WINDOW REGISTER BY ONE PIXEL AND VALUE OF THE OUTER POSITION OF RIGHT END THEREOF BY ONE PIXEL, IS SMALLER THAN W-3 (W: WINDOW SIZE) ?
YES
NO
S65
OPERATION & OUTPUT= (AVERAGE VALUE RANGING FROM THE INNER POSITION OF ONE END OF WINDOW BY ONE PIXEL TO THE INNER POSITION OF THE OTHER END THEREOF BY ONE PIXEL IS CALCULATED IN UPPER AND LOWER DIRECTIONS OR LEFT AND RIGHT DIRECTIONS WITH RESPECT TO REMARKED PIXEL)
S66
THE DIFFERENCE BETWEEN ORIGINAL VALUE AND VALUE AFTER OPERATION IS SMALLER THAN 1 ?
YES
NO
L2
L2'

EP0926860 SEP 1998

Fig.7

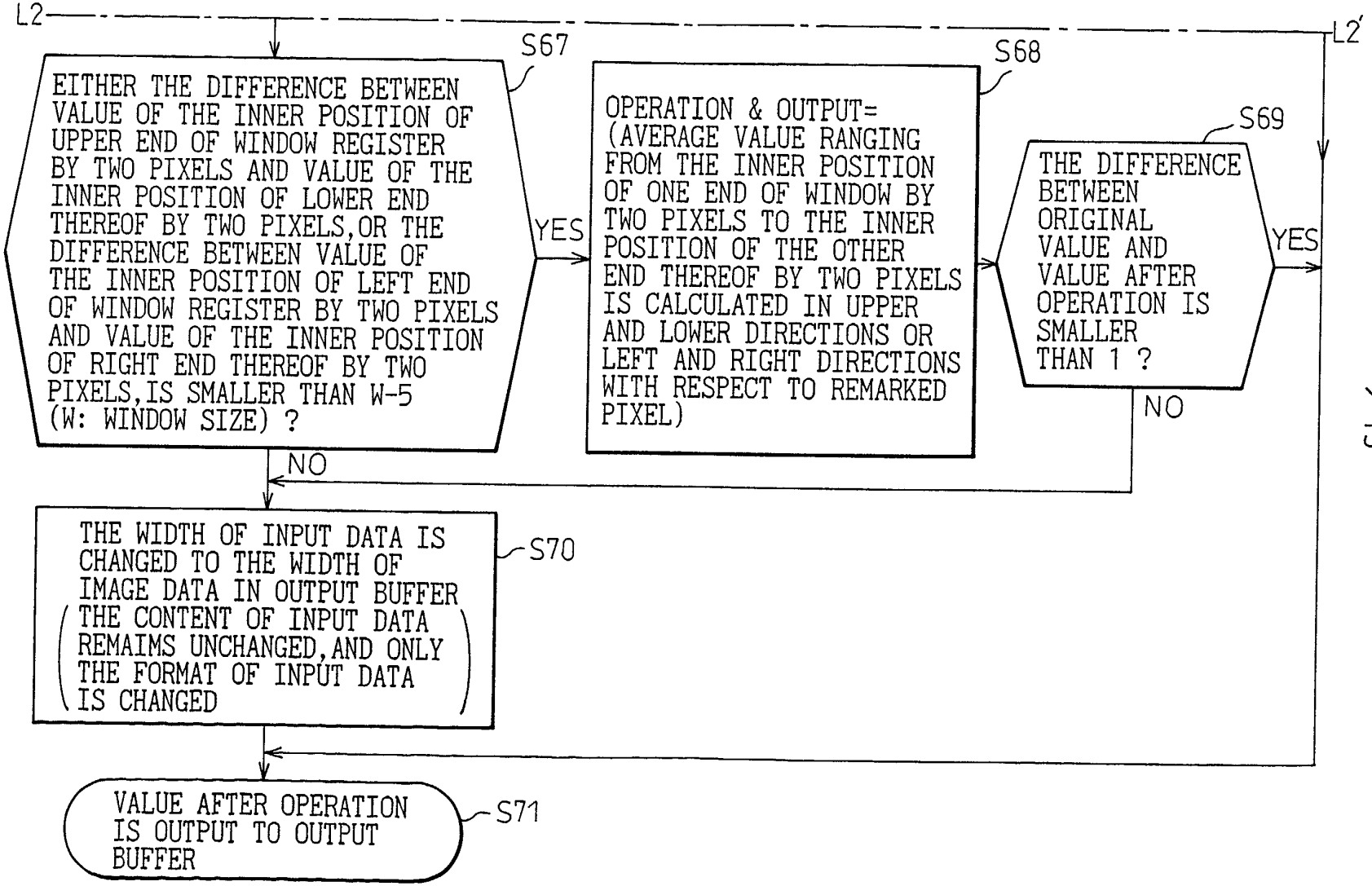


Fig.8

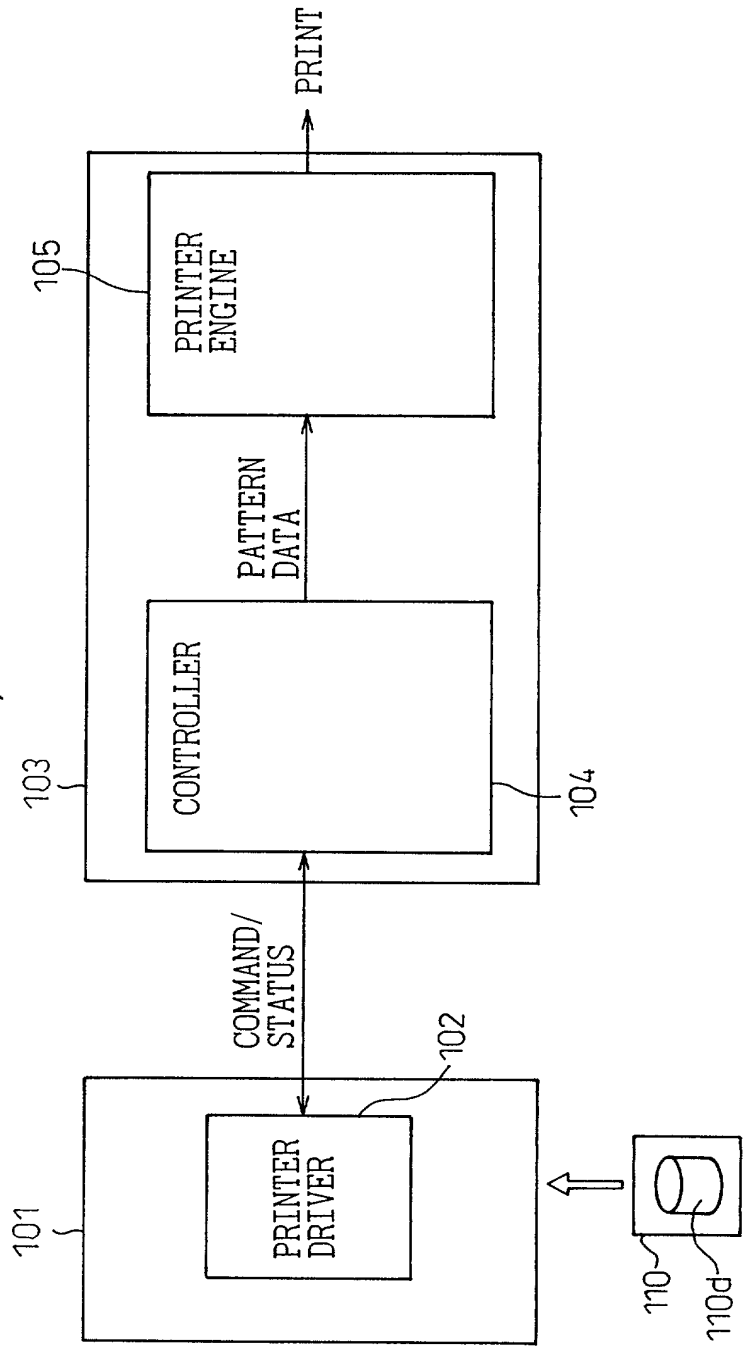

100
PRINT
105
PRINTER ENGINE
PATTERN DATA
CONTROLLER
103
104
COMMAND/ STATUS
102
PRINTER DRIVER
101
110
110d

Fig.9

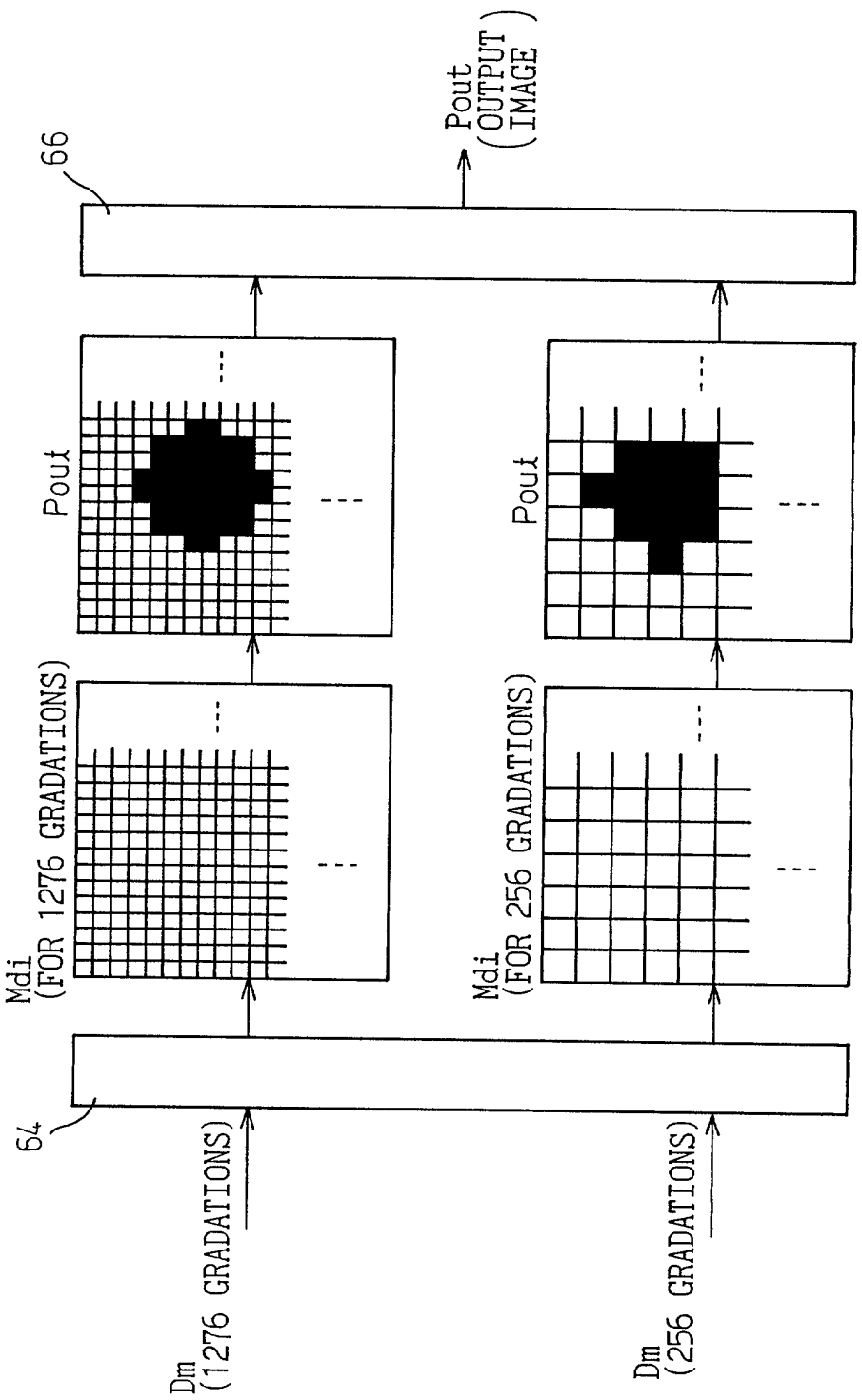

Dm
(1276 GRADATIONS)
Dm
(256 GRADATIONS)
64
Mdi
(FOR 1276 GRADATIONS)
Mdi
(FOR 256 GRADATIONS)
Pout
Pout
66
Pout
(OUTPUT
IMAGE)

Fig.10

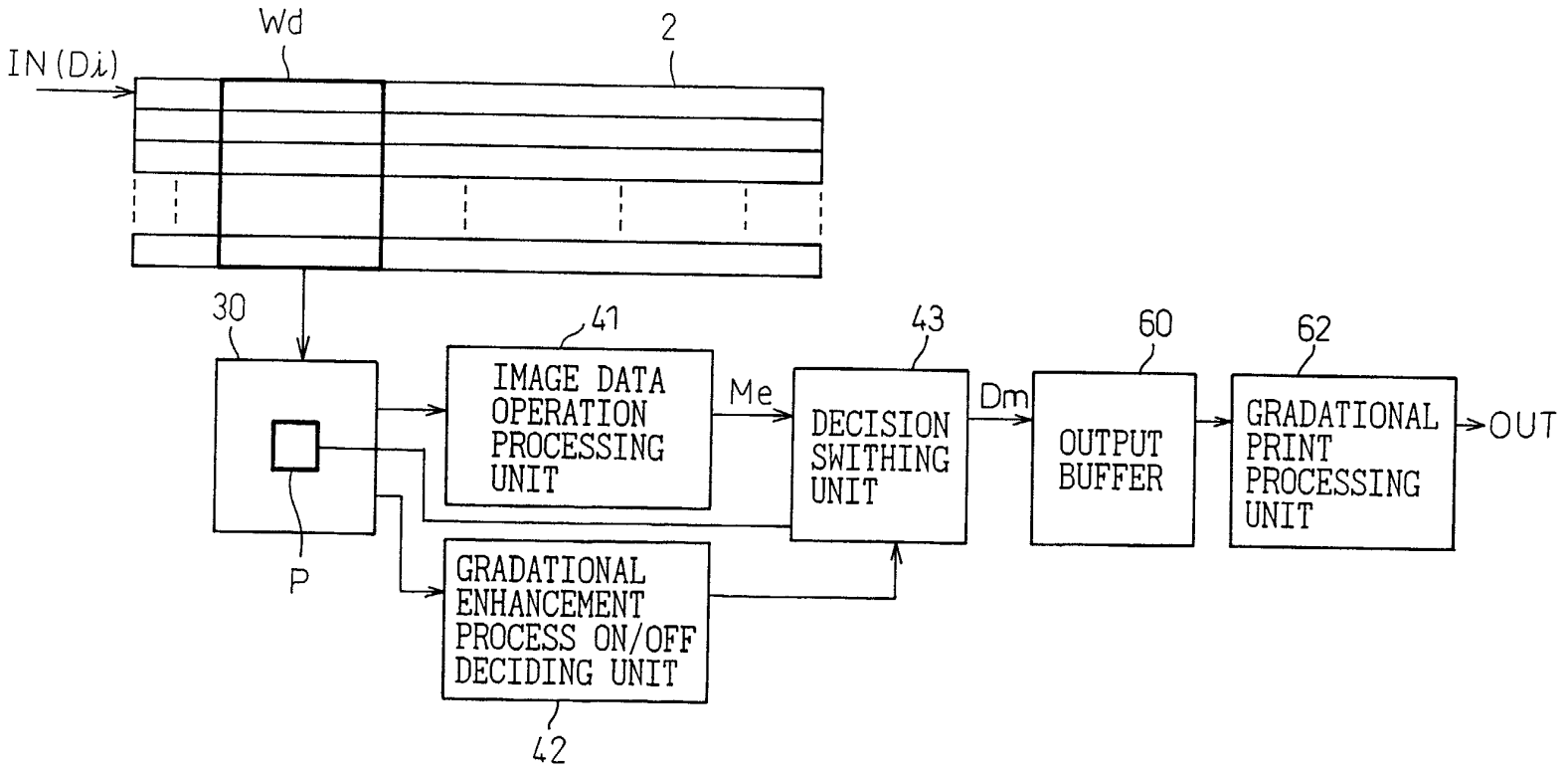

IN (Di)
Wd
2
30
41
IMAGE DATA OPERATION PROCESSING UNIT
Me
43
DECISION SWITHING UNIT
Dm
60
OUTPUT BUFFER
62
GRADATIONAL PRINT PROCESSING UNIT
OUT
P
GRADATIONAL ENHANCEMENT PROCESS ON/OFF DECIDING UNIT
42

Fig.11

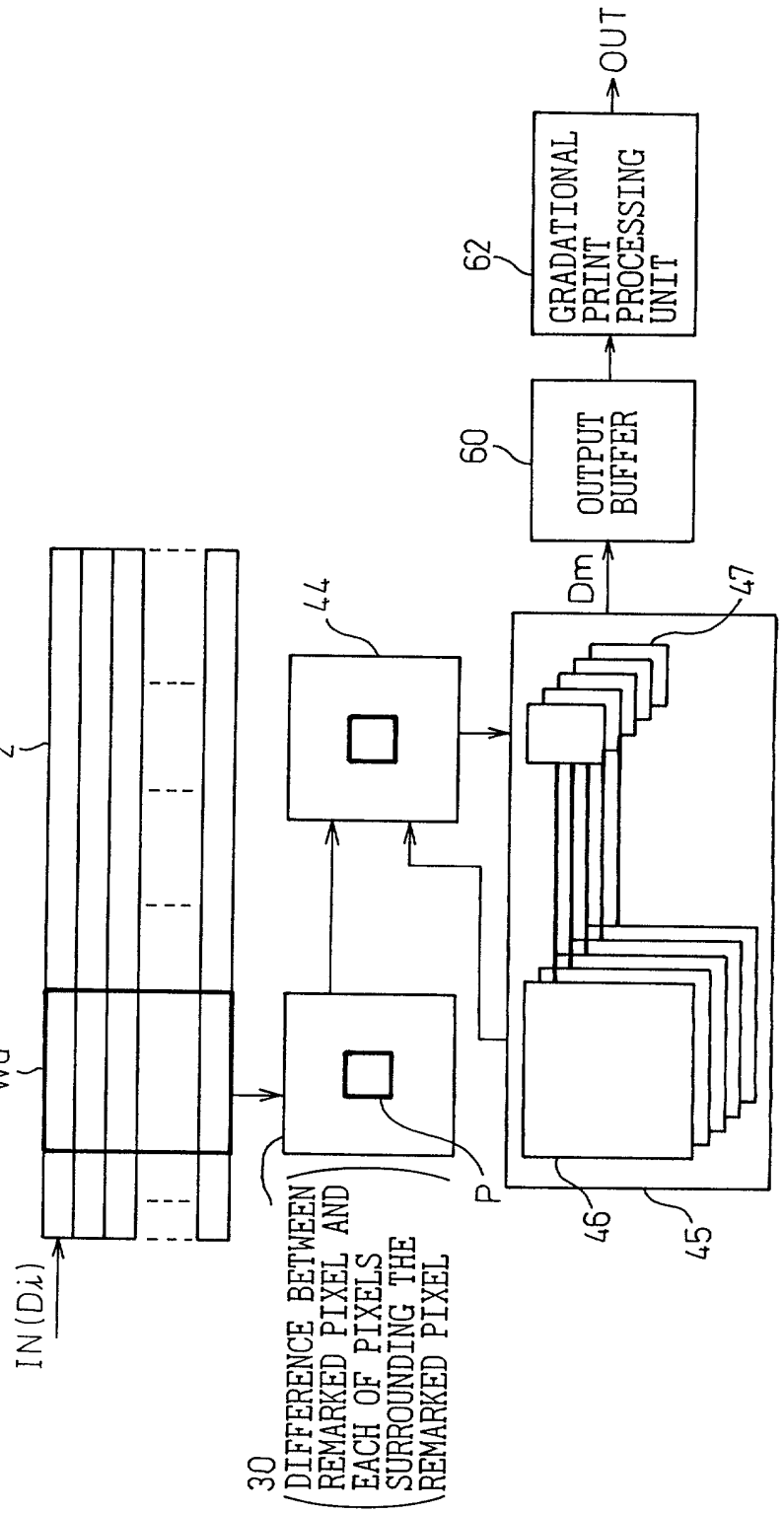

IN(Di)
Wd
2
30
DIFFERENCE BETWEEN REMARKED PIXEL AND EACH OF PIXELS SURROUNDING THE REMARKED PIXEL
44
P
46
45
47
Dm
60
OUTPUT BUFFER
62
GRADATIONAL PRINT PROCESSING UNIT
OUT

Fig.12

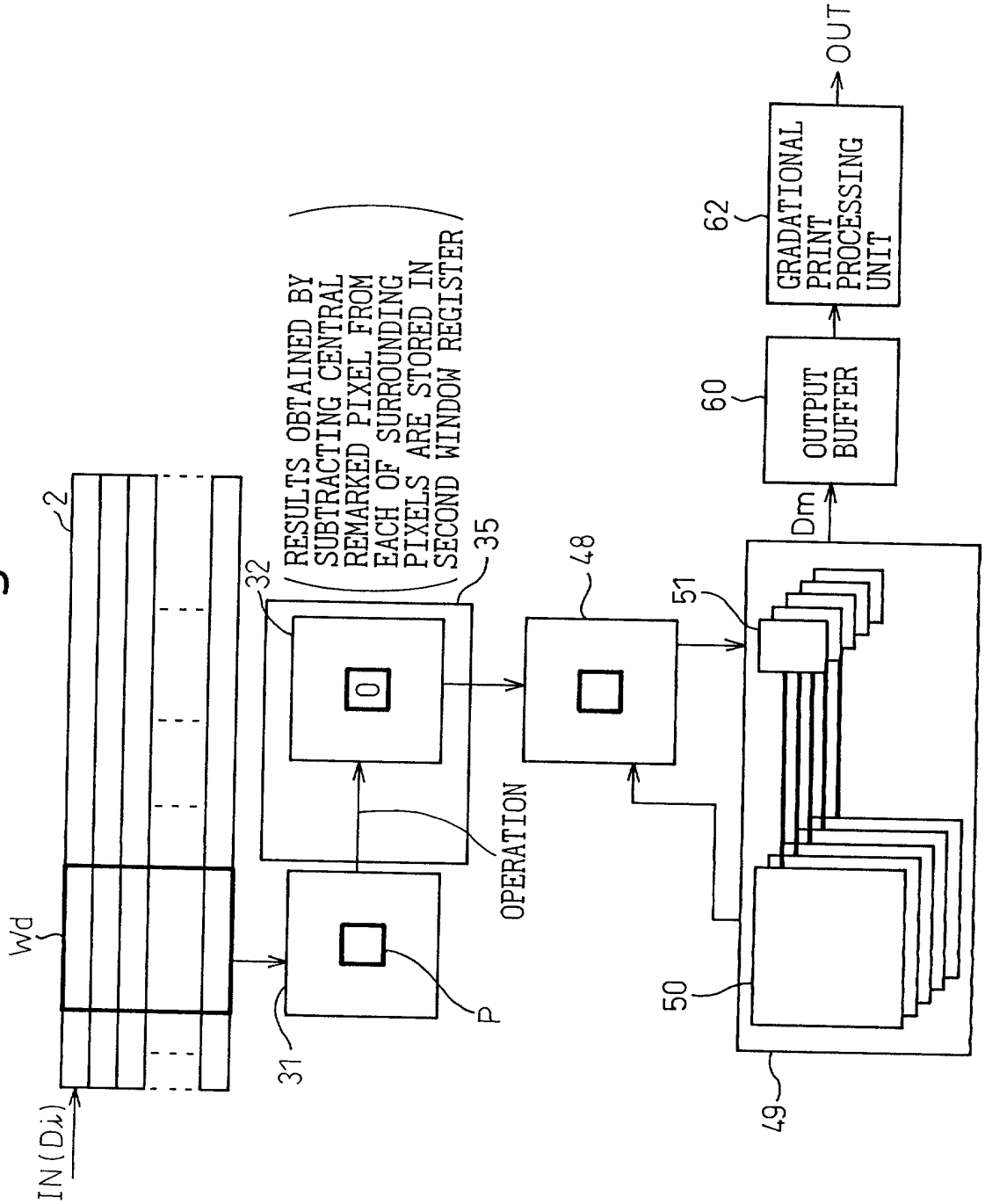

IN(Di)
Wd
2
31
32
35
P
OPERATION
RESULTS OBTAINED BY SUBTRACTING CENTRAL REMARKED PIXEL FROM EACH OF SURROUNDING PIXELS ARE STORED IN SECOND WINDOW REGISTER
48
51
50
49
Dm
60
OUTPUT BUFFER
62
GRADATIONAL PRINT PROCESSING UNIT
OUT

Fig.13

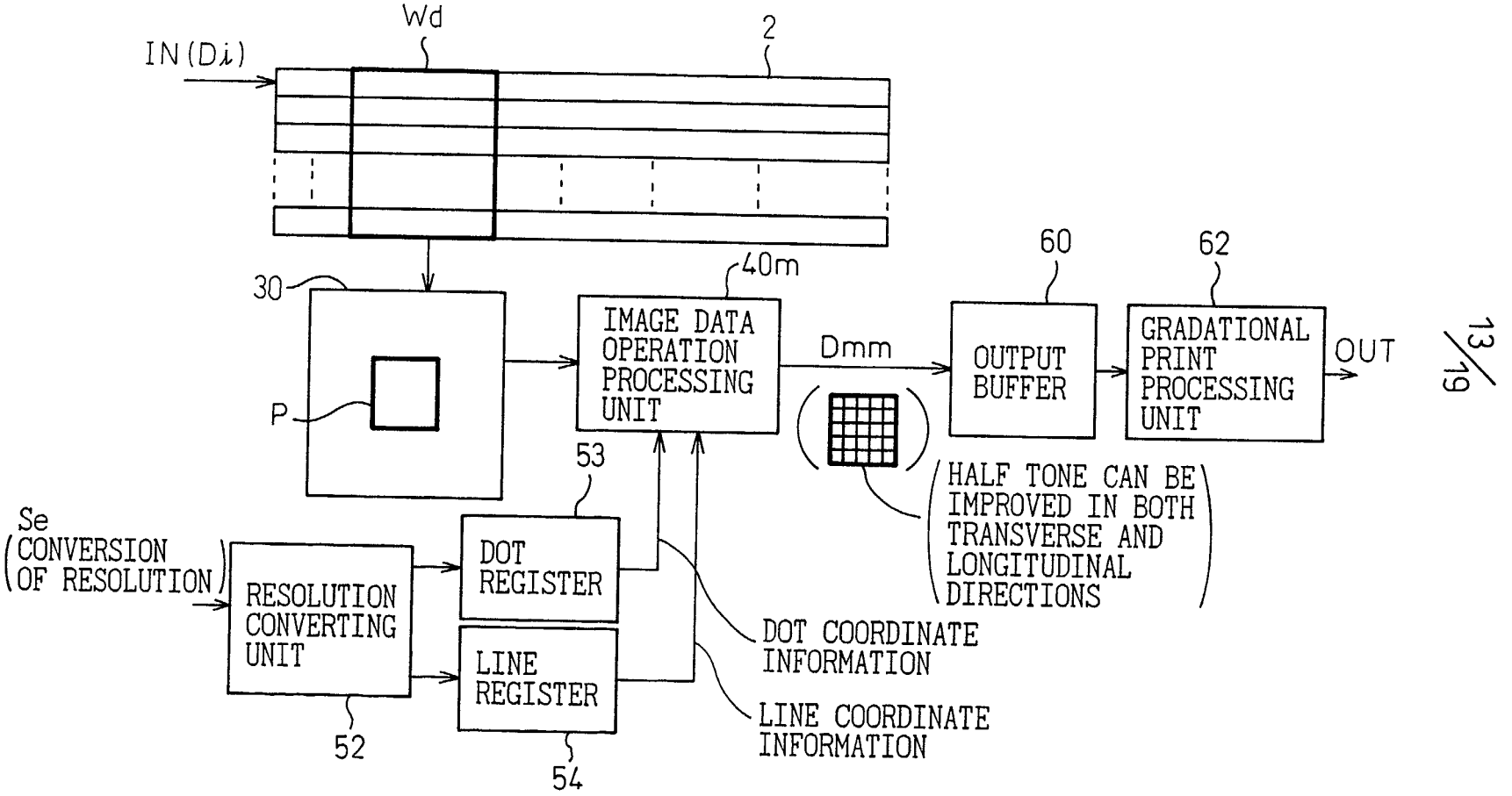

Wd
2
IN(Di)
30
P
40m
IMAGE DATA OPERATION PROCESSING UNIT
Dmm
60
OUTPUT BUFFER
62
GRADATIONAL PRINT PROCESSING UNIT
OUT
HALF TONE CAN BE IMPROVED IN BOTH TRANSVERSE AND LONGITUDINAL DIRECTIONS
53
Se
CONVERSION OF RESOLUTION
RESOLUTION CONVERTING UNIT
DOT REGISTER
LINE REGISTER
DOT COORDINATE INFORMATION
LINE COORDINATE INFORMATION
52
54

Fig.14

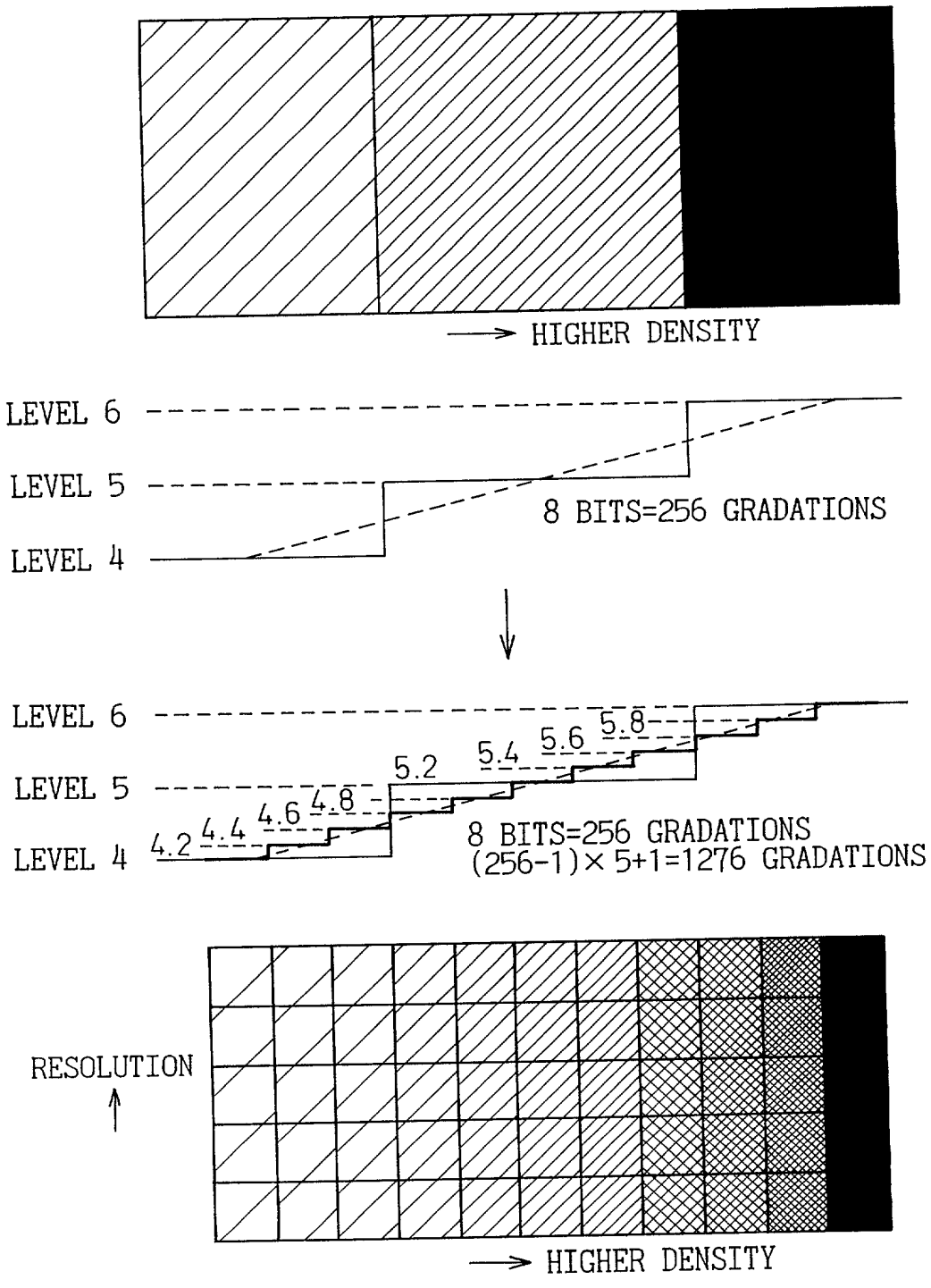

HIGHER DENSITY
LEVEL 6
LEVEL 5
LEVEL 4
8 BITS=256 GRADATIONS
LEVEL 6
LEVEL 5
LEVEL 4
4.2
4.4
4.6
4.8
5.2
5.4
5.6
5.8
8 BITS=256 GRADATIONS
(256-1)× 5+1=1276 GRADATIONS
RESOLUTION
HIGHER DENSITY

Fig.15

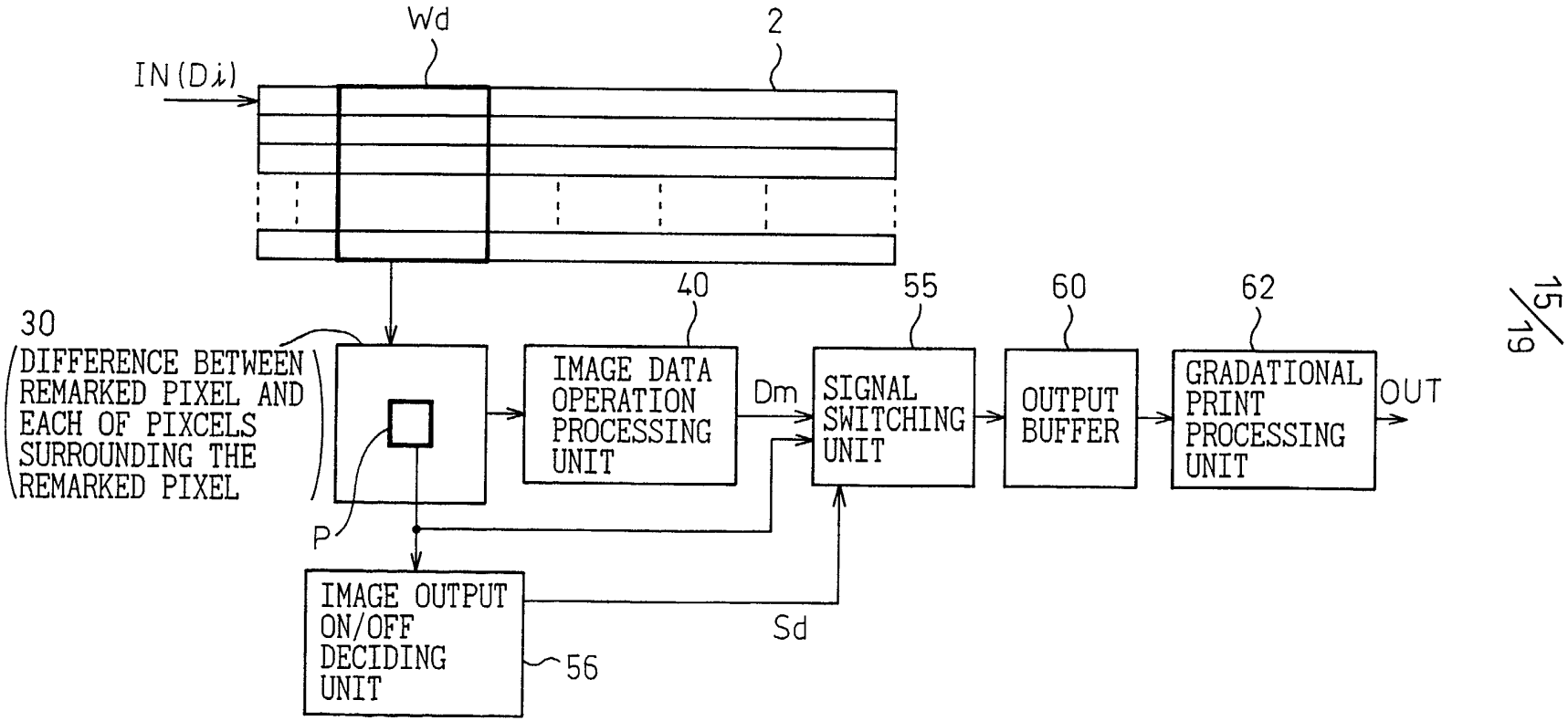

Wd
2
IN(Di)
30
DIFFERENCE BETWEEN REMARKED PIXEL AND EACH OF PIXCELS SURROUNDING THE REMARKED PIXEL
P
40
IMAGE DATA OPERATION PROCESSING UNIT
Dm
55
SIGNAL SWITCHING UNIT
60
OUTPUT BUFFER
62
GRADATIONAL PRINT PROCESSING UNIT
OUT
IMAGE OUTPUT ON/OFF DECIDING UNIT
56
Sd

Fig.16

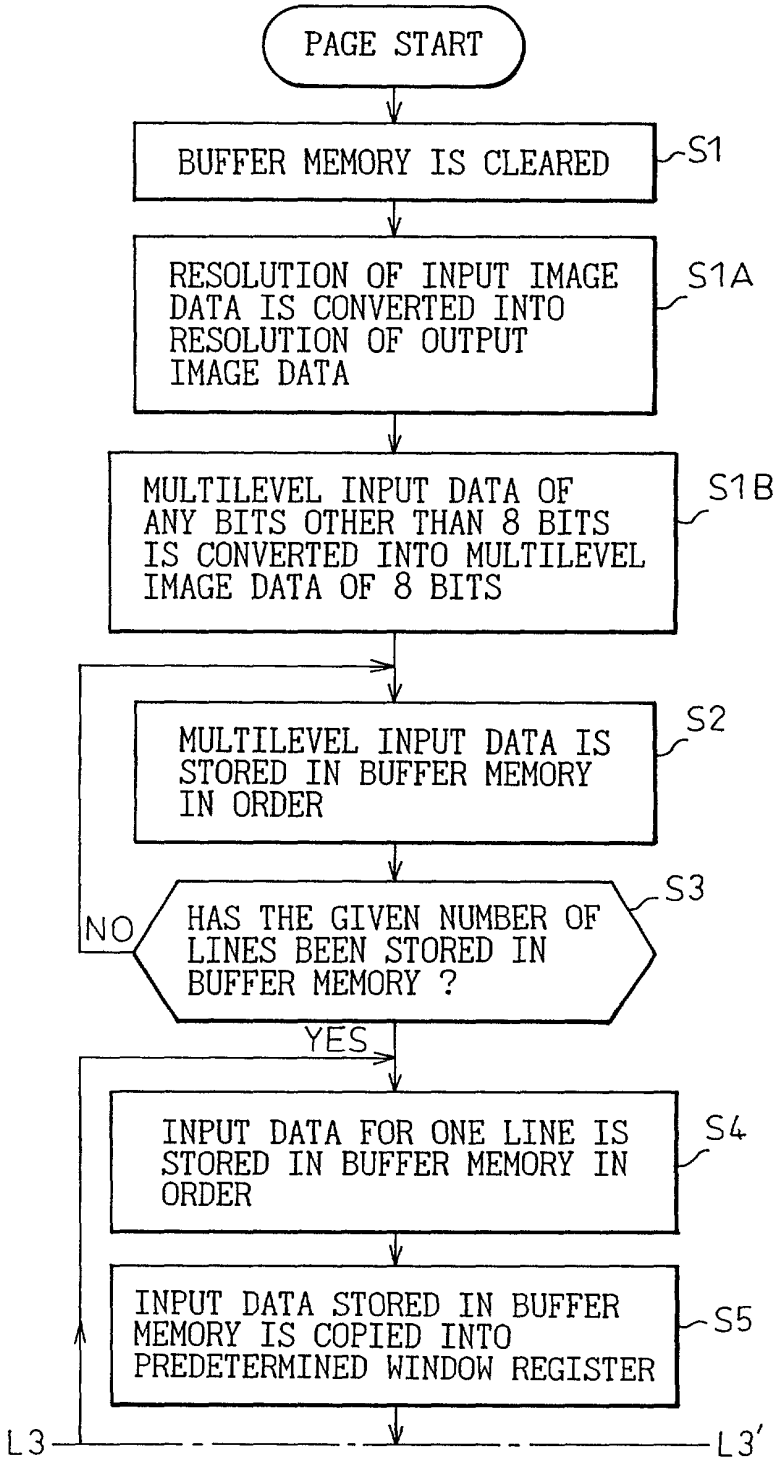

PAGE START
BUFFER MEMORY IS CLEARED
S1
RESOLUTION OF INPUT IMAGE DATA IS CONVERTED INTO RESOLUTION OF OUTPUT IMAGE DATA
S1A
MULTILEVEL INPUT DATA OF ANY BITS OTHER THAN 8 BITS IS CONVERTED INTO MULTILEVEL IMAGE DATA OF 8 BITS
S1B
MULTILEVEL INPUT DATA IS STORED IN BUFFER MEMORY IN ORDER
S2
HAS THE GIVEN NUMBER OF LINES BEEN STORED IN BUFFER MEMORY ?
S3
NO
YES
INPUT DATA FOR ONE LINE IS STORED IN BUFFER MEMORY IN ORDER
S4
INPUT DATA STORED IN BUFFER MEMORY IS COPIED INTO PREDETERMINED WINDOW REGISTER
S5
L3
L3'

Fig.17

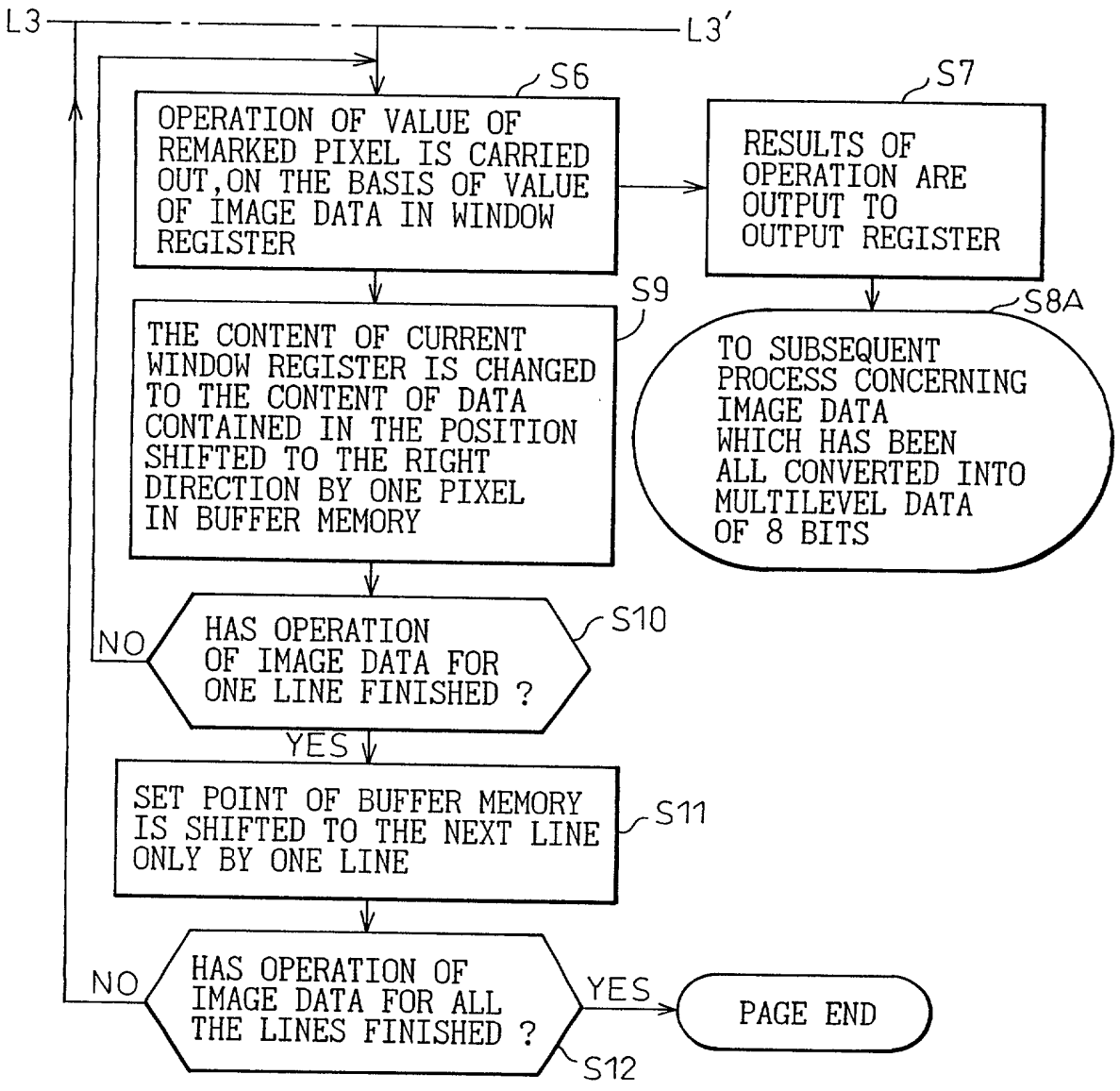

L3
L3'
S6
OPERATION OF VALUE OF REMARKED PIXEL IS CARRIED OUT, ON THE BASIS OF VALUE OF IMAGE DATA IN WINDOW REGISTER
S7
RESULTS OF OPERATION ARE OUTPUT TO OUTPUT REGISTER
S9
THE CONTENT OF CURRENT WINDOW REGISTER IS CHANGED TO THE CONTENT OF DATA CONTAINED IN THE POSITION SHIFTED TO THE RIGHT DIRECTION BY ONE PIXEL IN BUFFER MEMORY
S8A
TO SUBSEQUENT PROCESS CONCERNING IMAGE DATA WHICH HAS BEEN ALL CONVERTED INTO MULTILEVEL DATA OF 8 BITS
NO
HAS OPERATION OF IMAGE DATA FOR ONE LINE FINISHED ?
S10
YES
SET POINT OF BUFFER MEMORY IS SHIFTED TO THE NEXT LINE ONLY BY ONE LINE
S11
NO
HAS OPERATION OF IMAGE DATA FOR ALL THE LINES FINISHED ?
YES
PAGE END
S12

Fig.18

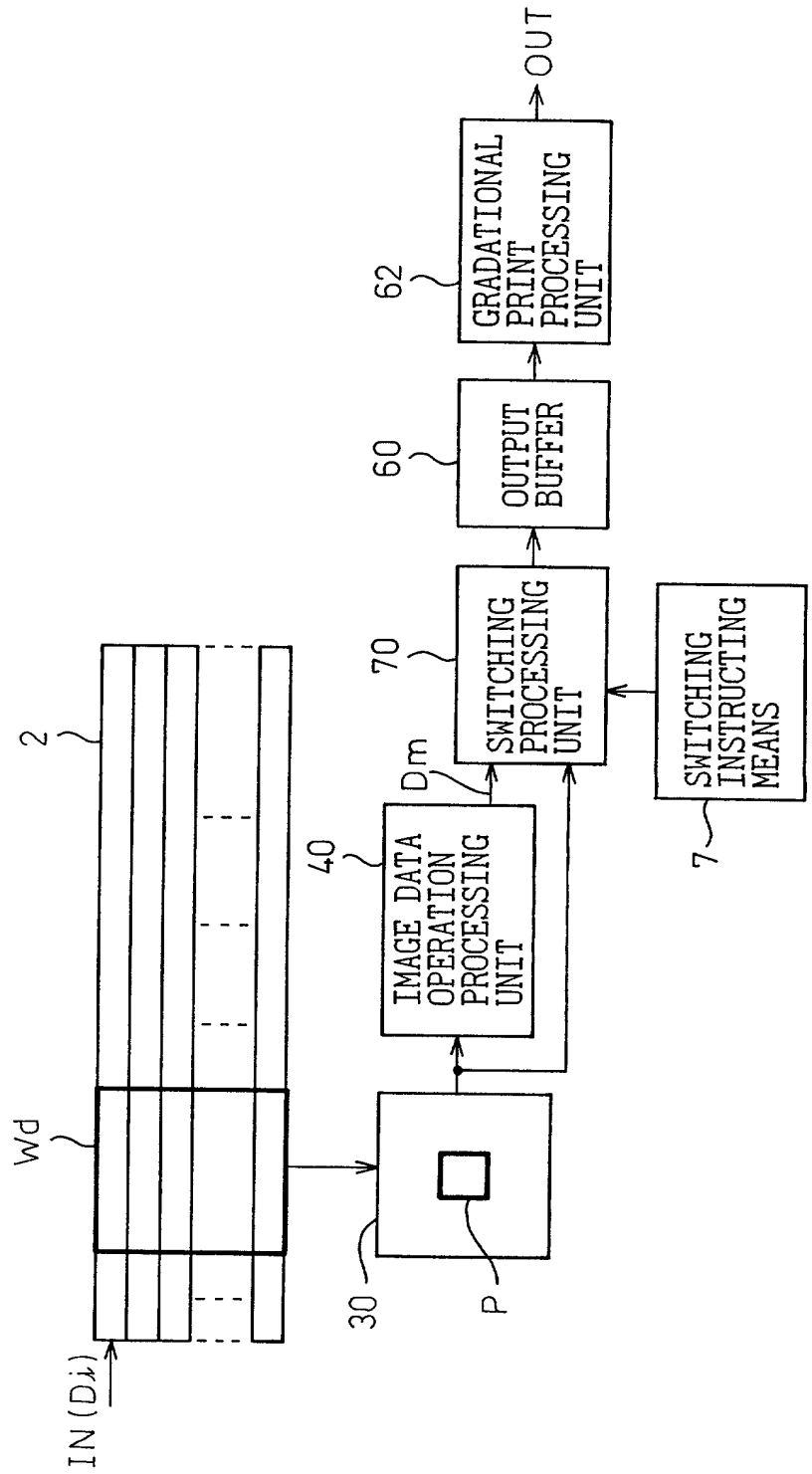
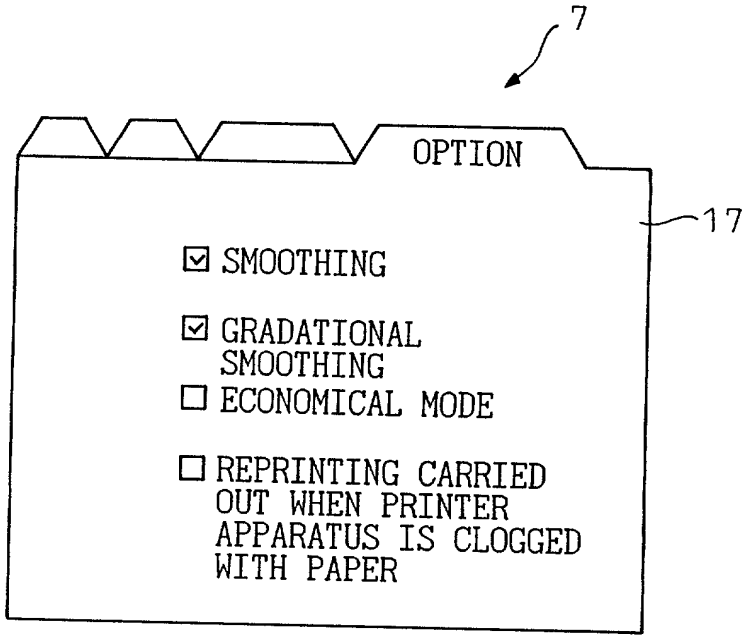

IN (Di)
2
Wd
30
P
40
IMAGE DATA OPERATION PROCESSING UNIT
Dm
70
SWITCHING PROCESSING UNIT
7
SWITCHING INSTRUCTING MEANS
60
OUTPUT BUFFER
62
GRADATIONAL PRINT PROCESSING UNIT
OUT

Fig. 19


7
OPTION
17
SMOOTHING
GRADATIONAL SMOOTHING
ECONOMICAL MODE
REPRINTING CARRIED OUT WHEN PRINTER APPARATUS IS CLOGGED WITH PAPER